PATENT SPECIFICATION

612,415

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Application Date (in United Kingdom): March 28, 1945. No. 7892/45.

Complete Specification Accepted: Nov. 12, 1948.

Under Rule 17A of the Patents Rules 1939-47, the proviso to Section 91 (4) of the Patents & Designs Acts, 1907 to 1946 became operative on April 14, 1947.

Index at acceptance:—Class 39(i), D1(c: e1: e2b: f: h), D(9c: 9f: 10d: 11: 16: 31: 46).

COMPLETE SPECIFICATION

Magnetron Electron Discharge Devices

We, MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, a company organised under the laws of Great Britain, of Marconi Offices, Electra House, Victoria Embankment, London, W.C.2, assignees of JOHN SCOTT DONAL, Jr., BARREMORE BEVERLY BROWN, and CARMEN LOUIS CUCCIA, all citizens of the United States of America, of 115, Snowden Lane, Princeton, New Jersey, 32, Hawthorne Avenue, Princeton, New Jersey, and 21, Hawthorne Avenue, Princeton, New Jersey, United States of America, respectively, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to magnetron electron discharge devices of the type having a plurality of cavity resonators surrounding and opening into a cylindrical cathode chamber.

Magnetrons of this type operating at ultra-high frequencies may be of several kinds. For example they may comprise a solid anode block having slots formed therein and extending from the cylindrical cathode chamber, the slots constituting the cavity resonators and connecting together adjacent anode segments, or they may comprise an anode formed of a conductive cylindrical member having, extending from its inner surface, a plurality of conductive radial slats or fins the inner ends of the slats or fins defining the cylindrical cathode chamber and constituting the anode segments. In this second kind, the cavity resonators are defined by adjacent slats and a portion of the cylindrical member. In the first kind above referred to the slots may be enlarged at their closed ends the enlargements being of circular cross section. Such magnetrons will be referred to, both in the following description and in the claims as of the type referred to.

[*Price 2/-*]

According to the present invention, a magnetron electron discharge device of the second kind, of the type referred to wherein alternate anode segments are conductively connected or strapped together by means of a first ring-like conductor and intermediate segments are connected together by means of a second ring-like conductor, the two ring-like conductors being otherwise out of electrical connection with each other and concentrically disposed relatively to each other and to the cylindrical cathode chamber, is characterised in that the anode segments are provided with end slots which together constitute an annular groove coaxial with the cathode chamber, and that the first and second ring-like conductors are of different sizes *inter-se* and each has deformations therein forming extensions therefrom perpendicular to the plane thereof and spaced apart by angular distances respectively equal to the angular spacing between alternate anode segments, the first and second ring-like conductors being disposed within the annular groove so that the extensions of one make electrical and mechanical connection with alternate anode segments at the base of the annular groove and the extensions of the other make electrical and mechanical connection with intermediate anode segments at the base of the annular groove.

Also according to the present invention, a magnetron electron-discharge device of the first kind of the type referred to wherein alternate anode segments are conductively connected or strapped together by means of a first ring-like conductor and intermediate segments are connected together by means of a second ring-like conductor, the two ring-like conductors being otherwise out of electrical connection with each other and concentrically disposed relatively to each other and to the cylindrical cathode chamber, is characterised in that the anode segments

are provided with end slots which together constitute a cylindrical depression coaxial with the cathode chamber the rising wall of the slots in alternate anode segments having a step facing towards the cathode chamber into the cylindrical depression and the slots in the intermediate anode segments being provided with a member forming a continuation of the cathode chamber and having a step facing away from the cathode chamber into the cylindrical depression, and that the first and second ring-like conductors are of different sizes *inter se* and are disposed within the cylindrical depression so that one makes electrical connection with and is fixedly located by the step on the rising wall and the other makes electrical connection with and is fixedly located by the step on the members with which intermediate segments are provided.

Also according to the present invention, a magnetron electron-discharge device of the first kind of the type referred to wherein alternate anode segments are conductively connected or strapped together by means of a first ring-like conductor and intermediate segments are connected together by means of a second ring-like conductor, the two ring-like conductors being otherwise out of electrical connection with each other and concentrically disposed relatively to each other and to the cylindrical cathode chamber, is characterised in that the anode segments are provided with end slots which together constitute an annular groove coaxial with the cathode chamber, and that the first and second ring-like conductors are of different sizes *inter-se* and each has sectors extending from the outer periphery thereof of equal angular extent to the angular extent of the anode segments and spaced apart by angular distances respectively equal to the angular spacing between alternate anode segments, the sector portions of the ring-like conductors being displaced out of the plane of the ring portion, and the first and second ring-like conductors being disposed relatively to the annular groove so that the outer peripheries of sectors of one make electrical and mechanical connection with the ends of alternate anode segments and the outer peripheries of the sectors of the other make electrical and mechanical connection with the ends of intermediate anode segments, and so that the ring-portions of the ring-like conductor having a diameter of one size pass within the annular groove, under and out of contact with the sectors extending from the outer periphery of the ring-like conductor having the diameter of the other size. As an alternative to this construction, the sector-portions of one ring-like conductor may pass under the ring-like portions of the other ring-like conductor.

Thus the invention provides magnetrons of the type referred to which, having improved methods of strapping, promote ease of construction, accuracy, and reproducibility of dimensions and spacings, so that such magnetrons can be reproduced of the same size which will operate at the same frequencies and at high efficiencies.

The invention will best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 is a top view, with parts removed to show details of construction of an electron discharge device made according to the invention, Fig. 2 is a longitudinal section taken along the line II—II of Fig. 1, Fig. 3 is a longitudinal section taken along the line III—III of Fig. 1, Fig. 4 is an enlarged view of the anode segments showing details of the strapping members employed in the device shown in Figs. 1, 2, and 3, Fig. 5 is a perspective view showing details of construction of a strapping member, Fig. 6 is a section taken along the line VI—VI of Fig. 4, Fig. 7 is a sectional view of a modification of the construction shown in Fig. 6, Figs. 8 to 13, inclusive, illustrate the steps in the construction of another form of strapping arrangement according to the invention, Figs. 14 and 15 show details of construction of an element utilised in Figs. 8 to 13, inclusive, Fig. 16 is a partial top view of a modification of the strapping arrangement shown in Fig. 4, Fig. 17 is a section taken along the line XVII—XVII of Fig 16, and Fig. 18 is a partial section showing a modification of the construction shown in Fig. 17.

Referring to Figs. 1 to 6, a magnetron discharge device of the type referred to employing the invention comprises an anode block 21 supporting a plurality of radially directed slats or fins 22 which extend toward the centre and the inner ends of which provide the anode segments and define the cathode space in which the cathode 23 is axially situated. The cathode is supported by magnetic insert member 24, a second magnetic insert member 25 being situated opposite thereto. These two inserts form part of the magnetic circuit which is completed by a magnet having poles 24' and 25'. The cathode and inserts are supported by means of conducting bridging members 26 and 27 which are in turn supported from the anode block by means of the bolts 28 and 29 insulated by means of in-

sulating tubular members 30, 31, 32 and 33, and by means of the bushes 30^1 and 32^1, see Figure 2.

This electrode assembly is mounted on header member 35 to which an envelope 36 is sealed, the header and envelope are made of non-magnetic material, for example, stainless steel. The cathode and heater leads 37 and 38 extend through the header and are sealed therein by means of elongated insulating tubular members 37^1 and 38^1. One of the cavity resonators formed between the slats 22 has coupling member 39 which forms the inner conductor of coaxial line coupled thereto. The outer tubular conductor 40 of the coaxial line has an insulating member 41 hermetically sealed thereto. Cooling fins 42 may be secured to the header.

As shown in Figs. 4 and 6, each of the radially directed slats or anode elements 22 is provided with a slot 45 for receiving a strapping ring 46 as shown in greater detail in Fig. 5. This strapping ring is provided with a plurality of deformations or extensions 48, see particularly Figure 5, perpendicular to the plane of the ring and so situated that they make contact with alternate slats as shown in Fig. 4. To such rings are provided, one of which 46^1, Fig. 4, is of smaller diameter than the other ring 46. It is provided with extensions 48^1 similar to extensions 48 of ring 46. Deformations 48^1 engage and are electrically connected to the anode slats not engaged by deformations 48. Thus during operation the voltage on alternate anode segments are in phase, and in opposition to intermediate anode segments. As shown in Fig. 6, ring 46 is electrically connected at 48 to the slat which is spaced from the ring 46^1, and ring 46^1 is electrically connected at 48^1 to the slat which is spaced from ring 46.

In the arrangement shown in Fig. 7 slot 45 in the slats is stepped so that the rings are positively located with respect to each other, the inner strapping ring engaging the inner step and the outer ring engaging the outer step, lateral movement between the rings thereby being prevented.

In the case of magnetrons formed from a block by means of slots extending radially from a central chamber, a different approach to the attainment of the object of the invention is made. Referring to Figs. 8 to 15, slots 51 result in the provision of a plurality of anode segments 50, the inner ends of which surround the cathode space in which the cathode 52 is axially mounted. The anode segments are recessed as indicated at 53. The element 54 shown in Fig. 14 is then placed in position as indicated in Fig. 10. This element 54 is provided with three projections 55, the outer portions of which are formed to provide steps 56. Likewise a ring 57 provided with a step 58 is placed within recess 53 in contact with the vertical wall of the recess. After being secured in position element 54 and the ring 57 are cut along the slots and alternate portions of the ring 57 are left as indicated in Fig. 10. It is noted that the step portions of element 54 are mounted at the ends of the segments in between those segments in which the step ring portions 57 are left. The portions of element 54 between the extensions 55 provide the inner wall 54^1 as shown in Figs. 11 and 12. It is now possible to place two rings 59 and 60 within the recess 53, the outer ring being supported by the step ring 57 connecting alternate anode segments and the inner ring being supported by the step portions 56 of the spider, the relationship of the inner and outer rings being shown in Fig. 13. Thus a most accurate location of the rings results.

A further method would be to place sectors 57 of conducting material, such as shown in Fig. 11, on alternate segments adjacent the periphery of the recess.

A further modification of the strapping arrangement is shown in Fig. 16. Here a pair of spiders is utilised, one of the spiders 74 being provided with extensions or legs 75 so that every other anode segment between the slots 71 is connected by this spider. The second spider 72 is situated over the first spider, the legs 72 thereof engaging the anode segments between the first mentioned group of segments. The relationship of the two spiders is shown in Fig. 17, the ring portions of the spiders extending within the slots 70^2 in the anode segments 70.

In the modification shown in Fig. 18, the spider 73^1, corresponding to spider 73 of Fig. 16, may be deformed as indicated so that it passes under the ring portion of spider 74.

We are aware of United Kingdom Patent Specification 588,916, which was not available at the date hereof though it bears an earlier date, and which claims a high frequency electrical oscillator of the specific magnetron type therein referred to, characterised in that the number of possible modes or frequencies in which oscillations may be generated is limited by the provision of electrical connections (hereinafter referred to as straps) between selected points on the resonator system.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A magnetron electron-discharge device of the second kind of the type referred to wherein alternate anode segments are conductively connected or strapped together by means of a first ring-like conductor and intermediate segments are connected together by means of a second ring-like conductor, the two ring-like conductors being otherwise out of electrical connection with each other and concentrically disposed relatively to each other and to the cylindrical cathode chamber, characterised in that the anode segments are provided with end slots which together constitute an annular groove coaxial with the cathode chamber, and that the first and second ring-like conductors are of different sizes *inter-se* and each has deformations therein forming extensions therefrom perpendicular to the plane thereof and spaced apart by angular distances respectively equal to the angular spacing between alternate anode segments, the first and second ring-like conductors being disposed within the annular groove so that the extensions of one make electrical and mechanical connection with alternate anode segments at the base of the annular groove and the extensions of the other make electrical and mechanical connection with intermediate anode segments at the base of the annular groove.

2. A modification of the device as claimed in claim 1, wherein the annular groove is provided with a secondary annular groove in the annular floor thereof so as to provide annular steps in the rising walls thereof, and wherein the first and second ring-like conductors are disposed within the first-mentioned annular groove so that the extensions of one ring-like conductor make electrical and mechanical connection with alternate intermediate anode segments at the base of the secondary annular groove by one rising wall of which it is fixedly located and the extensions of the other ring-like conductor make electrical and mechanical connection with intermediate anode segments at the base of the secondary annular groove by the other rising wall of which it is fixedly located.

3. A magnetron electron-discharge device of the first kind of the type referred to wherein alternate anode segments are conductively connected or strapped together by means of a first ring-like conductor and intermediate segments are connected together by means of a second ring-like conductor, the two ring-like conductors being otherwise out of electrical connection with each other and concentrically disposed relatively to each other and to the cylindrical cathode chamber, characterised in that the anode segments are provided with end slots which together constitute a cylindrical depression coaxial with the cathode chamber the rising wall of the slots in alternate anode segments having a step facing towards the cathode chamber into the cylindrical depression and the slots in the intermediate anode segments being provided with a member forming a continuation of the cathode chamber and having a step facing away from the cathode chamber into the cylindrical depression, and that the first and second ring-like conductors are of different sizes *inter se* and are disposed within the cylindrical depression so that one makes electrical connection with, and is fixedly located by, the step on the rising wall, and the other makes electrical connection with, and is fixedly located by, the step on the members with which intermediate segments are provided.

4. A device as claimed in claim 3, wherein the steps facing towards the cathode chamber with which alternate anode segments are provided are produced from a conductive ring having an enlarged internal diameter over approximately half its height and a constant external diameter substantially equal to the diameter of the cylindrical depression into which depression it is inserted and fixed, the ring being then severed at places corresponding with the slots between adjacent anode segments and alternate portions of the ring being removed.

5. A device as claimed in claim 3 or 4, wherein the members forming a continuation of the cathode chamber and having steps facing away therefrom are produced from a ring-shaped body having sectors extending from the outer periphery thereof of equal angular extent to the angular extent of the anode segments and spaced apart by angular distances respectively equal to the angular spacing between alternate anode segments the extensions having arcuate outer circumstances of two different diameters to form steps therein, and the inner diameter of the ring-shaped body being equal to the diameter of the cathode chamber, the ring-shaped body being inserted into and fixed in the cylindrical depression and then severed at places corresponding with the slots between adjacent anode segments.

6. A magnetron electron-discharge device of the first kind of the type referred to wherein alternate anode segments are conductively connected or strapped together by means of a first ring-like conductor and intermediate segments are connected together by means of a second

ring-like conductor, the two ring-like conductors being otherwise out of electrical connection with each other and concentrically disposed relatively to each other and to the cylindrical cathode chamber characterised in that the anode segments are provided with end slots which together constitute an annular groove coaxial with the cathode chamber, and that the first and second ring-like conductors are of different sizes *inter-se* and each has sectors extending from the outer periphery thereof of equal angular extent to the angular extent of the anode segments and spaced apart by angular distances respectively equal to the angular spacing between alternate anode segments, the sector portions of the ring-like conductors being displaced out of the plane of the ring portion, and the first and second ring-like conductors being disposed relatively to the annular groove so that the outer peripheries of sectors of one make electrical and mechanical connection with the ends of alternate anode segments and the outer peripheries of the sectors of the other make electrical and mechanical connection with the ends of intermediate anode segments, and so that the ring-portions (or the sector-portions) of the ring-like conductor having a diameter of one size pass, within the annular groove, under and out of contact with the sectors extending from the outer periphery (or the ring-like portions) of the ring-like conductor having the diameter of the other size.

7. Magnetron electron discharge devices, substantially as described with reference to the accompanying drawings.

Dated this 28th day of March, 1945.
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24, Southampton Buildings,
London, W.C.2.

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612,415 COMPLETE SPECIFICATION

SHEET 1

[This Drawing is a reproduction of the Original on a reduced scale.]

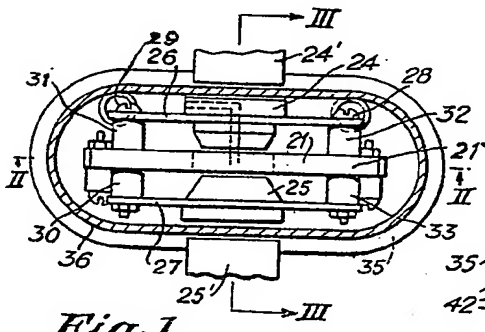


Fig. 1.

Fig. 2.

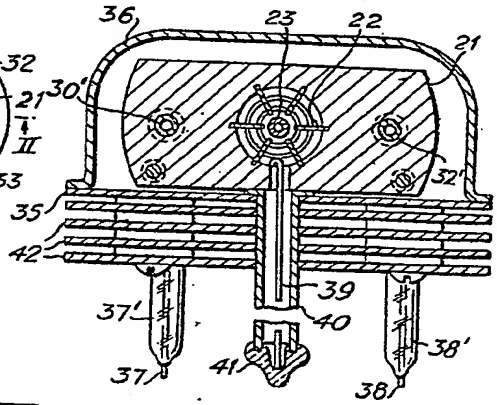
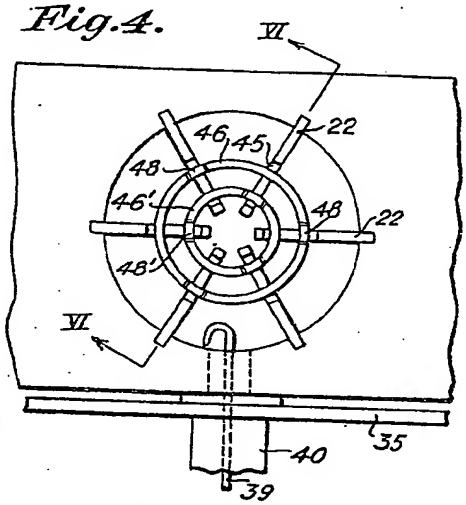


Fig. 4.



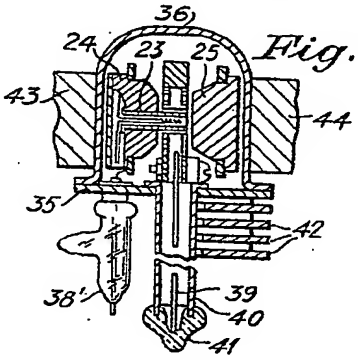
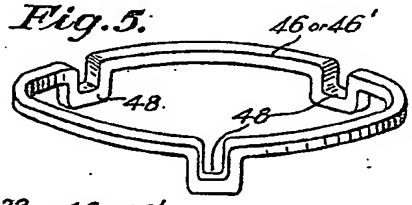


Fig. 3.

Fig. 5.



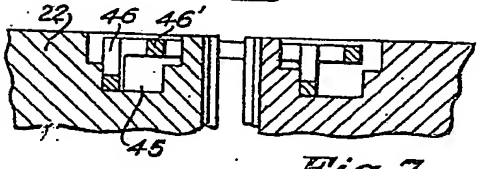


Fig. 7.

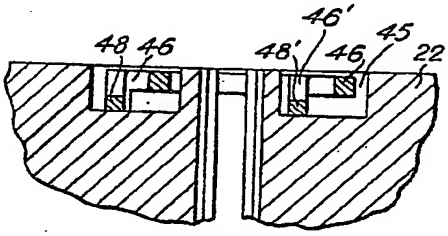


Fig. 6.

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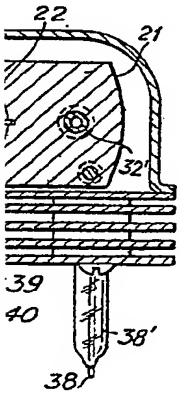

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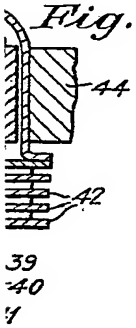

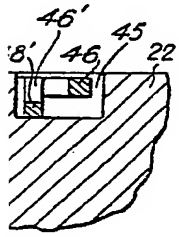

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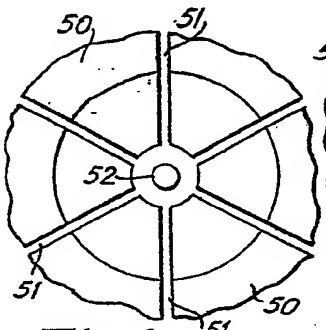


Fig. 8.

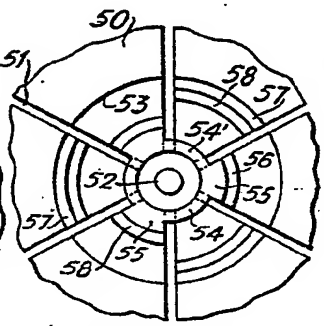


Fig. 10.

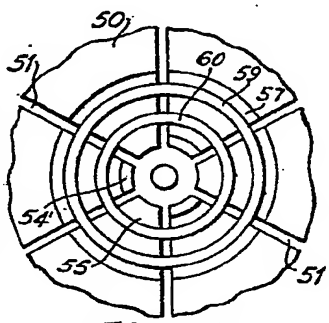


Fig. 12.

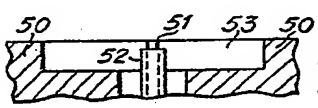


Fig. 9.

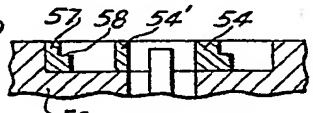


Fig. 11.

Fig. 13.

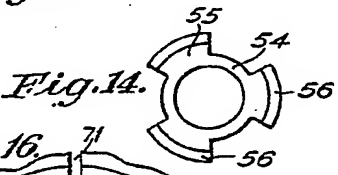


Fig. 14.

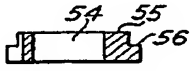


Fig. 15.

Fig. 16.

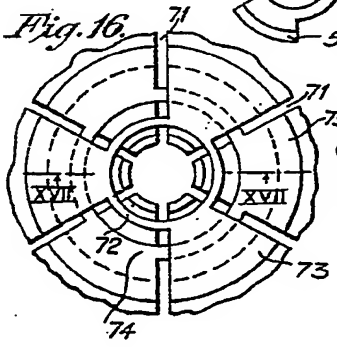


Fig. 17.

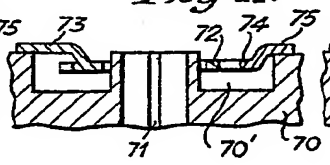
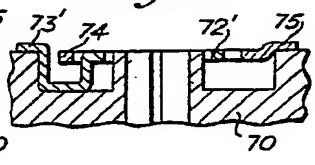


Fig. 18.



612,415 COMPLETE SPECIFICATION

2 SHEETS

SHEET 1

SHEET 2

[This Drawing is a reproduction of the Original on a reduced scale]

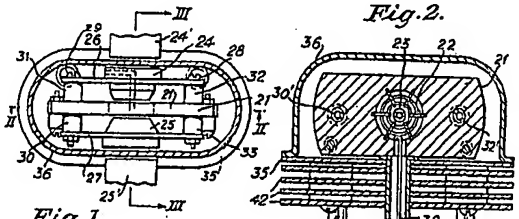


Fig.1.

Fig.2.

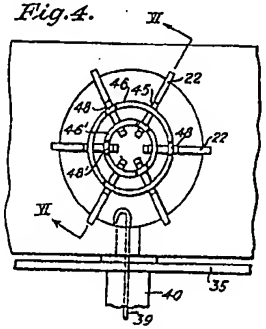


Fig.4.

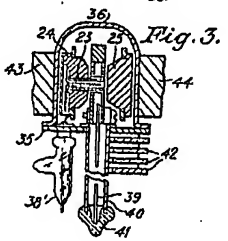


Fig.3.

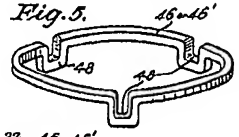


Fig.5.

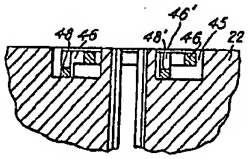


Fig.6.

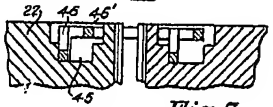


Fig.7.

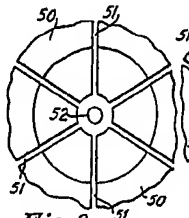


Fig.8.

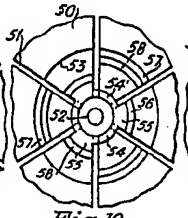


Fig.10.

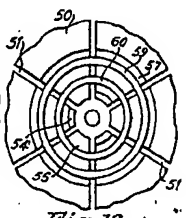


Fig.12.

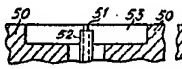


Fig.9.

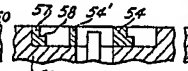


Fig.11.

Fig.13.

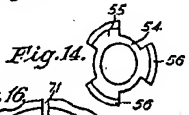


Fig.14.

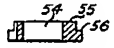


Fig.15.

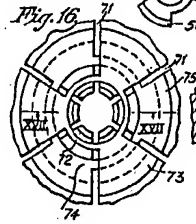


Fig.16.

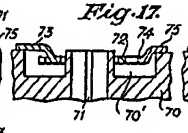


Fig.17.

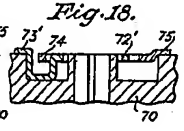


Fig.18.

H.M.S.O.(Ty P.)